

## 1673 News Notes: July 2002 Edition

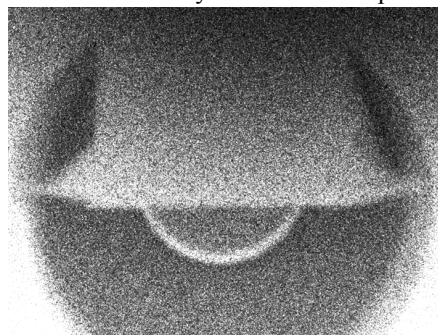
### Hemispherical capsule implosions in a fast-ignitor geometry

Experiments led by David Hanson ([dlhanso@sandia.gov](mailto:dlhanso@sandia.gov)) and Roger Vesey ([ravesey@sandia.gov](mailto:ravesey@sandia.gov)) have begun looking at hemispherical capsule implosions on the Z-machine. The goal of these experiments is to begin studying capsule implosions in a compression geometry relevant to “fast ignition” experiments. The hemispheres are in a secondary hohlraum directly above a z pinch located in a primary hohlraum. Unlike the experiments studying spherical capsule implosions (see June 2002 News Notes), which use two z pinches located above and below the capsule, these experiments use a single z-pinch as shown to the right.

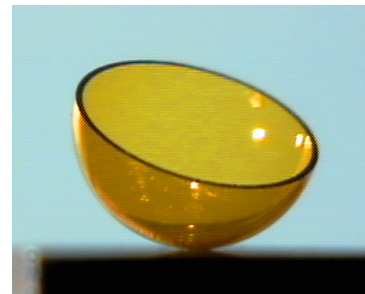
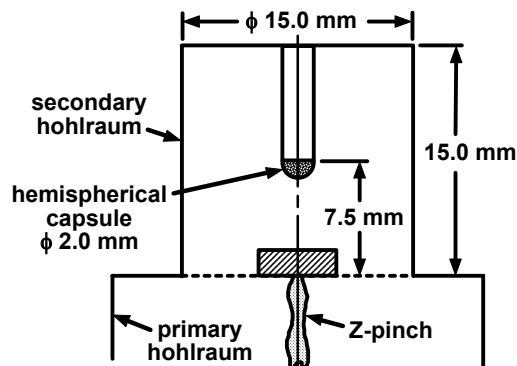
In the traditional approach to inertial confinement fusion, a spherical capsule shell containing deuterium and tritium fuel is compressed to a density of order  $1000 \text{ g/cm}^3$  (for comparison, solid deuterium is  $0.3 \text{ g/cm}^3$ ) at pressures  $>10^{11}$  times atmospheric pressure. Though material under these conditions will rapidly fly apart, the inertia of the imploding material is sufficient to confine the mass for about  $10^{-11}$  to  $10^{-10}$  seconds. This time is sufficient for at least a small portion of the capsule mass to reach the temperatures of about 100 million °C required for the deuterium and tritium ions to overcome the electrostatic forces repelling them and fuse (releasing energy in the process). From this “ignition spot” a thermonuclear burning wave expands, consuming the remaining material. To achieve these conditions, the pressure driving the capsule implosion must be extremely uniform.

Recent work suggests that an energetic Petawatt ( $10^{15} \text{ W}$ ) laser can be used as a “fast ignitor” to create an ignition spot in a capsule. In this case, it might be possible to ignite fusion reactions at a lower density (about 5 times) than required by the traditional approach. This in principle reduces the symmetry requirements of the driver facility, and also separates the mechanism for compressing the capsule from the mechanism for generating a hot spot. This fast ignitor approach should also be more energy efficient, which would allow for more robust and economically feasible reactor designs in the future.

Why use hemispherical capsules? To ignite the dense region of an imploding capsule, the laser beam energy is first converted into energetic electrons or ions (research is in progress to determine which technique is more practical). The energetic electrons or ions, when they reach the dense portion of the imploded capsule, are absorbed and release their energy, heating the mass to the ignition temperature. One technical problem for fast ignition is getting the laser beam and a converter close enough to the dense region at the center of a capsule to ignite the capsule. Experiments in Japan have used cones inserted into a spherical capsule such that the tip of the cone was near the capsule center. The laser beam can then be focused near the tip of the cone, and the cone will prevent material from the capsule from interfering with the laser beam. Another possible approach is to use hemispherical capsules, so that instead of inserting a cone into a spherical capsule one can use a “half-sphere”. One advantage of this geometry is that in principle a single z-pinch can be used to drive the capsule implosion using a smaller secondary hohlraum, making the system more energy-efficient than the double-z-pinch-driven hohlraum experiments discussed in previous News Notes. A second advantage of this geometry is that it may allow us to study the interface boundary between the imploding capsule and the surface of the mounting stand holding the capsule in place.



The experiments performed to date have concentrated on finding a hemispherical implosion geometry suitable for radiography experiments using the Z-Beamlet laser. After some initial failures due to the high-energy x-ray background present in wire-array z pinches, we have successfully obtained images of imploding hemispherical capsules using 6.7 keV x rays. An example image from such a test is shown here. In addition to the capsule, the gold plasma ablated from the untamped edge of the pedestal can be seen in the image. At present, work on hemispherical capsule implosions has been limited to relatively few tests, but as the Petawatt laser project at Sandia progresses (see April 2002 News Notes) this effort will be increased.



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